TABLE B–2.—DUTY CYCLE FOR CONSTANT-SPEED PROPULSION ENGINES—Continued

Mode No.	Engine speed [1] (percent of maximum test speed)	Percent of maximum test power [2]	Minimum time in mode (minutes)	Weighting factors
2	100	75	5.0	0.50
3	100	50	5.0	0.15
4	100	25	5.0	0.15

[1] Engine speed: #2 percent of point.
[2] Power: #2 percent of engine maximum value.

(2) For the purpose of determining compliance with the emission standards of §94.8, variable-speed propulsion engines that are used with (or intended to be used with) variable-pitch propellers or with electrically coupled propellers shall be tested using the duty cycle described in Table B–3, which follows:

TABLE B–3.—DUTY CYCLE FOR VARIABLE SPEED PROPULSION ENGINES USED ON NON-PROPELLER LAW VESSELS AND FOR VARIABLE SPEED AUXILIARY ENGINES

Test segment	Mode No.	Engine speed [1]	Percent of maximum test torque [2]	Minimum time in mode (minutes)	Weighting factors
1	1	Maximum Test Speed	100	5.0	0.15
1	2	Maximum Test Speed	75	5.0	0.15
1	3	Maximum Test Speed	50	5.0	0.15
1	4	Maximum Test Speed	10	5.0	0.10
2	5	Intermediate	100	5.0	0.10
2	6	Intermediate	75	5.0	0.10
2	7	Intermediate	50	5.0	0.10
2	8	Idle	0	5.0	0.15

[1] Engine speed (non-idle): #2 percent of point. Engine speed (idle): Within manufacturer's specifications. Idle speed is specified by the manufacturer.
[2] Torque (non-idle): #2 percent of engine maximum value. Torque (idle): minimum fueling rate Load less than 5 percent of peak torque.

(d) *Auxiliary*. For the purpose of determining compliance with the emission standards of §94.8:

(1) Constant speed auxiliary engines shall be tested using the duty cycle described in Table B–4, which follows:

TABLE B–4.—DUTY CYCLE FOR CONSTANT-SPEED AUXILIARY ENGINES

Mode No.	Engine speed [1]	Percent of maximum test torque [2]	Minimum time in mode (minutes)	Weighting factors
1	Maximum Test Speed	100	5.0	0.05
2	Maximum Test Speed	75	5.0	0.25
3	Maximum Test Speed	50	5.0	0.30
4	Maximum Test Speed	25	5.0	0.30
5	Maximum Test Speed	10	5.0	0.10

[1] Engine speed: #2 percent of point.
[2] Torque: #2 percent of engine maximum value.

(2) Variable speed auxiliary engines shall be tested using the duty cycle described in Table B–3 in paragraph (c)(2) of this section.

§94.106 Supplemental test procedures.

This section describes the test procedures for supplemental testing conducted to determine compliance with the exhaust emission requirements of §94.8(e). In general, the supplemental

test procedures are the same as those otherwise specified by this subpart, except that they cover any speeds, loads, ambient conditions, and operating parameters that may be experienced in use. The test procedures specified by other sections in this subpart also apply to these tests, except as specified in this section.

(a) Notwithstanding other provisions of this subpart, testing conducted to determine compliance with the exhaust emission requirements of §94.8(e) may be conducted:

(1) At any speed and load (or any combination of speeds and loads that is nominally steady-state) within the applicable Not To Exceed Zone specified in paragraph (b) of this section;

(2)(i) Without correction, at any intake air temperature between 13°C and 35°C (or between 13°C and 30°C for engines not drawing intake air directly from a space that could be heated by the engine);

(ii) Without correction at any ambient water temperature (or equivalent) between 5°C and 27°C;

(iii) Without correction at any ambient humidity between 7.1 and 10.7 grams of moisture per kilogram of dry air; and

(3) With a continuous sampling period not less than 30 seconds in duration.

(b) The specified Not to Exceed Zones for marine engines are defined as follows. These Not to Exceed Zones apply, unless a modified zone is established under paragraph (c) of this section.

(1) For Category 1 engines certified using the duty cycle specified in §94.105(a), the Not to Exceed zones are defined as follows:

(i) The Not to Exceed zone is the region between the curves power = $1.15 \times SPD^2$ and power = $0.85 \times SPD^4$, excluding all operation below 25% of maximum power at rated speed and excluding all operation below 63% of maximum test speed.

(ii) This zone is divided into two subzones, one above and one below 45% of maximum power at rated speed.

(iii) SPD in paragraph (b)(1)(i) of this section refers to percent of maximum test speed.

(iv) See Figure B–1 for an illustration of this Not to Exceed zone which follows:

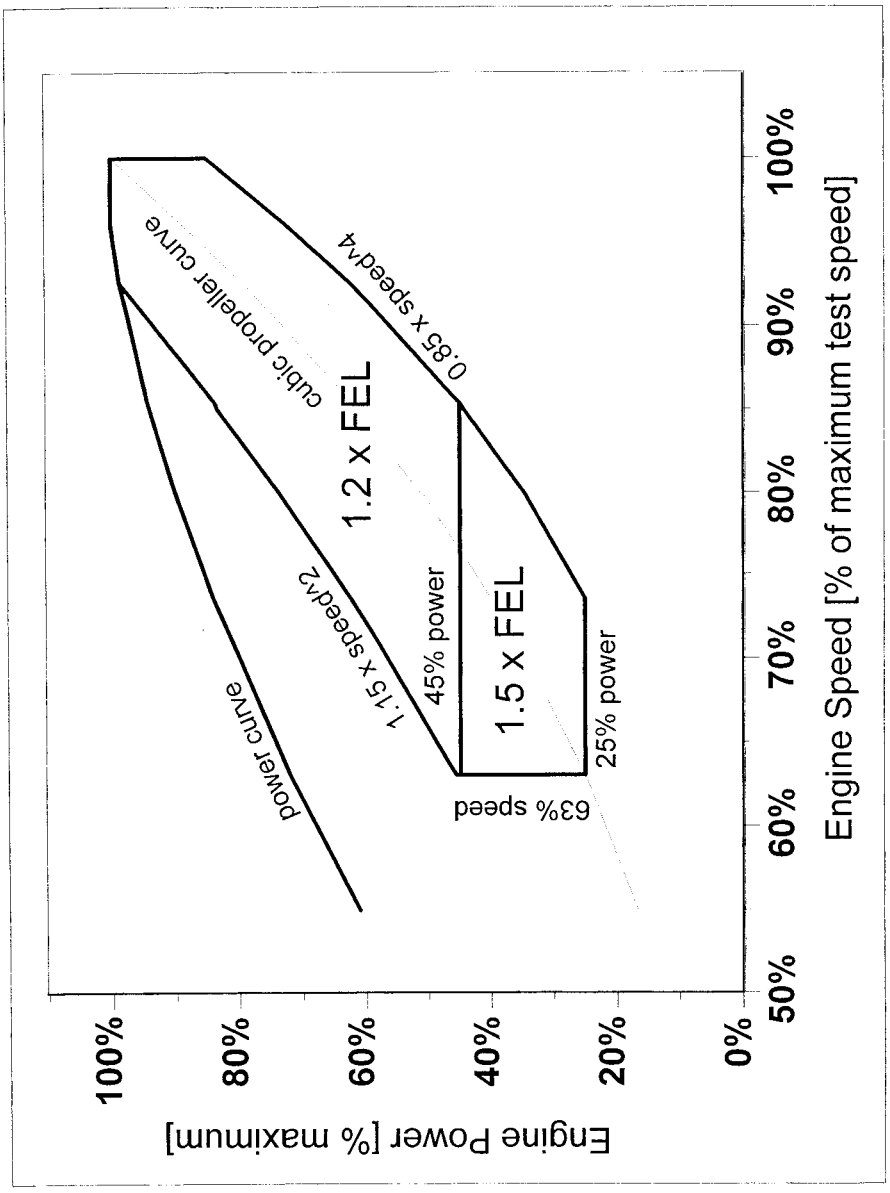


Figure B-1

(2) For Category 2 engines certified using the duty cycle specified in §94.105(a), the Not to Exceed zones are defined as follows:

(i) The Not to Exceed zone is the region between the curves power = 1.04 × SPD^2 and power = 0.76 × SPD^4, excluding all operation below 25% of maximum power at rated speed and excluding all operation below 63% of maximum test speed.

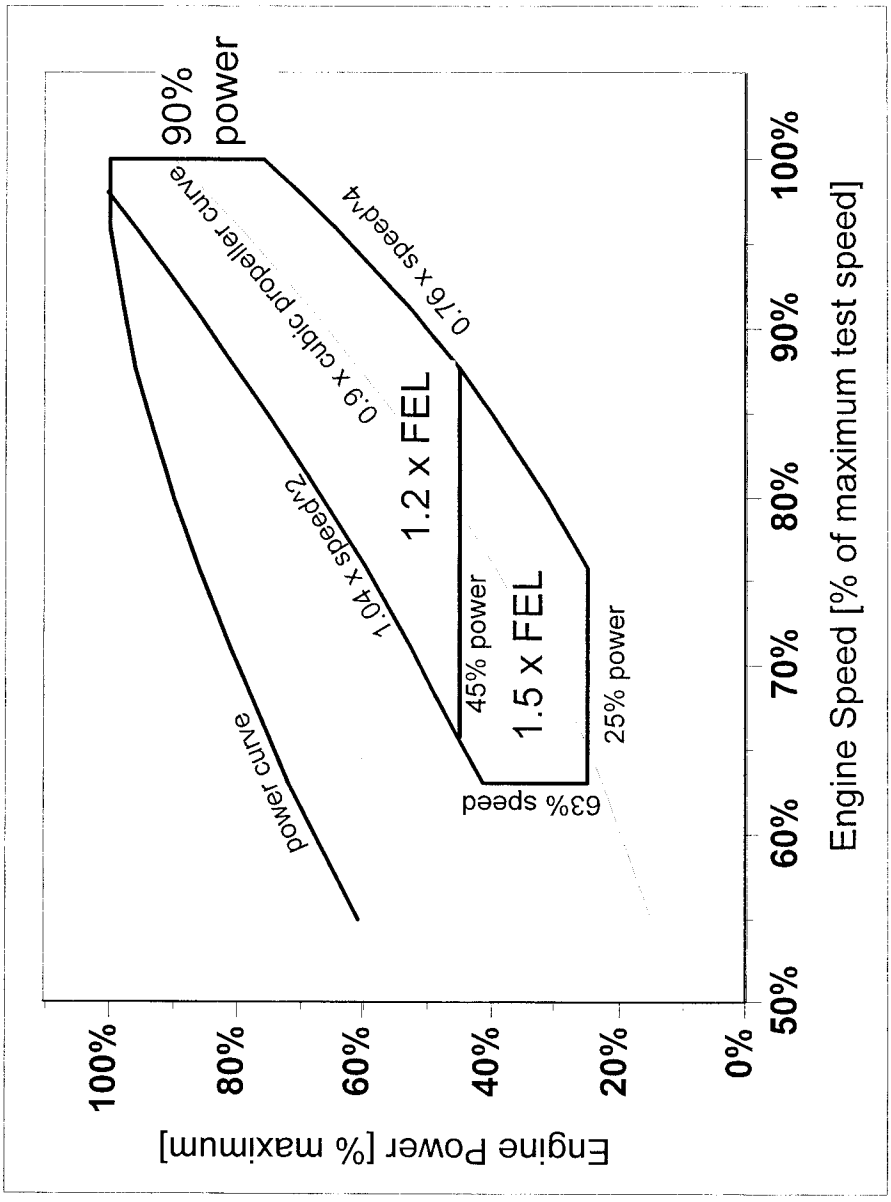
(ii) This zone is divided into two subzones, one above and one below 45% of maximum power at rated speed.

(iii) SPD in paragraph (b)(2)(i) of this section refers to percent of maximum test speed.

(iv) See Figure B–2 in paragraph (b)(3) of this section for an illustration of this Not to Exceed zone.

(3) For engines certified using the duty cycle specified in § 94.105(b)(2), the Not to Exceed zones are defined as follows:

Figure B-2



(i) The Not to Exceed zone is the region above the curve power = 0.85 × SPD^2, excluding all operation below 25% of maximum power at rated speed and excluding all operation below 63% of maximum test speed.

(ii) This zone is divided into two subzones, one above and one below 45% of maximum power at rated speed.

(iii) SPD in paragraph (b)(3)(i) of this section refers to percent of maximum test speed.

(iv) See Figure B–3 for an illustration of this Not to Exceed zone:

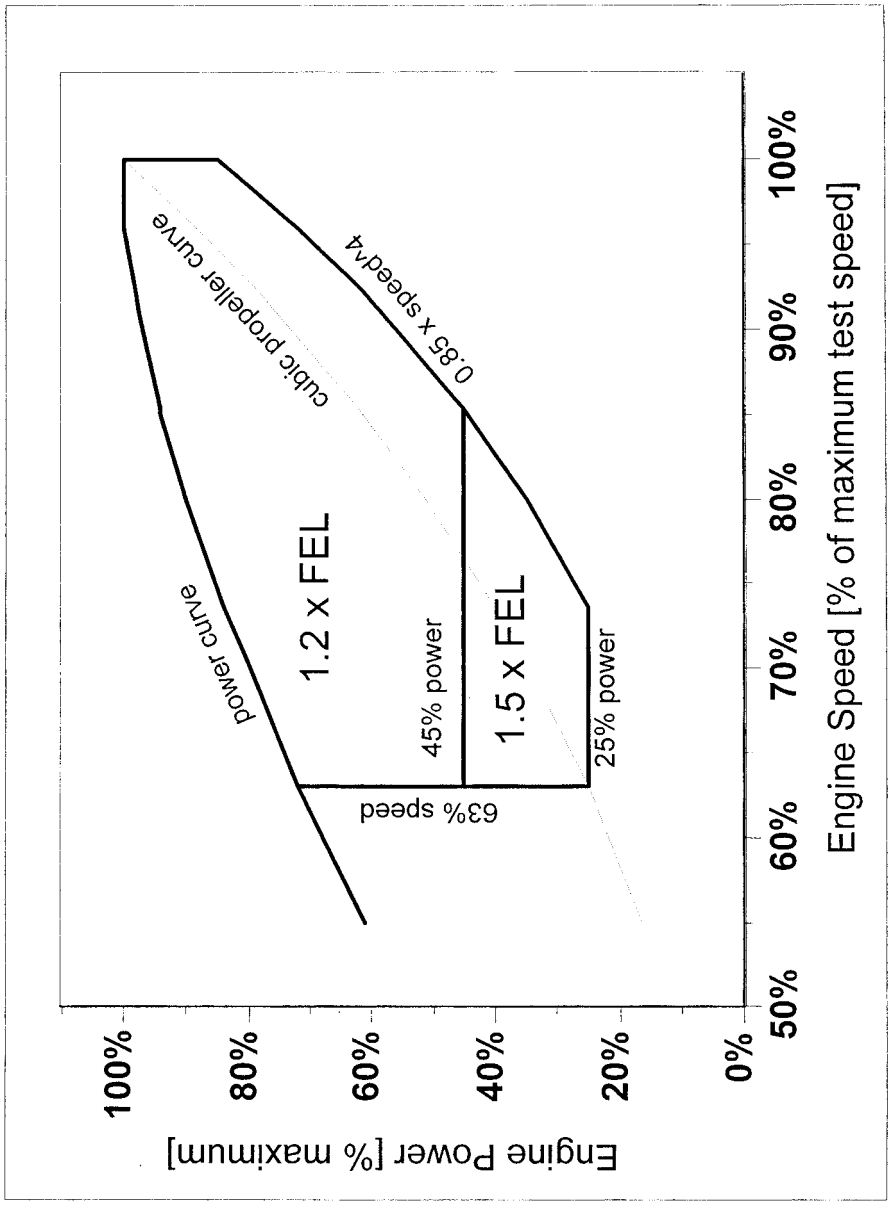


Figure B-3

(4) For engines certified using the duty cycle specified in § 94.105(b)(1), the Not to Exceed Zone is defined as any load greater than or equal to 25 percent of maximum power at rated speed, and at any speed at which the engine operates in use.

(c)(1) Upon request by the manufacturer, the Administrator may specify a

narrower Not to Exceed Zone for an engine family at the time of certification, provided that the narrower Not to Exceed Zone includes all speeds greater than 63 percent of maximum test speed and loads greater than 25 percent of maximum power at rated speed at which the engines are expected to normally operate in use.

(2) At the time of certification, the Administrator may specify, or require the manufacturer to specify, a broader Not to Exceed Zone for an engine family, provided that the broader Not to Exceed Zone includes only speeds greater than 63 percent of maximum test speed and loads greater than 25 percent of maximum power at rated speed at which the engines are expected to normally operate in use.

(d) Testing conducted to determine compliance with the exhaust emission requirements of §94.8(e) may be conducted at any ambient air temperature or humidity outside the ranges specified in paragraph (a)(2) of this section, provided that emission measurements are corrected to be equivalent to measurements within the ranges specified in paragraph (a)(2) of this section. Correction of emission measurements made in accordance with this paragraph (d) shall be made in accordance with good engineering practice. The measurements shall be corrected to be within the range using the minimum possible correction.

(e) Testing conducted under this section may not include engine starting.

§94.107 Determination of maximum test speed.

(a) *Overview.* This section specifies how to determine maximum test speed from a lug curve. This maximum test speed is used in §§94.105 and 94.106 (including the tolerances for engine speed specified in §94.105).

(b) *Generation of lug curve.* Prior to beginning emission testing, generate maximum measured brakepower versus engine speed data points using the applicable method specified in 40 CFR 86.1332. These data points form the lug curve. It is not necessary to generate the entire lug curve. For the portion of the curve where power increases with increasing speed, it is not necessary to generate points with power less than 90 percent of the maximum power value. For the portion of the curve where power decreases with increasing speed, it is not necessary to generate points with power less than 75 percent of the maximum power value.

(c) *Normalization of lug curve.* (1) Identify the point (power and speed) on the lug curve at which maximum power occurs.

(2) Normalize the power values of the lug curve by dividing them by the maximum power value identified in paragraph (b)(1) of this section, and multiplying the resulting values by 100.

(3) Normalize the engine speed values of the lug curve by dividing them by the speed at which maximum power occurs, which is identified in paragraph (b)(1) of this section, and multiplying the resulting values by 100.

(4) Maximum engine power is located on the normalized lug curve at 100 percent power and 100 percent speed.

(d) *Determination of maximum test speed.* Calculate the maximum test speed from the speedfactor analysis described in this paragraph (d).

(1) For a given combination of engine power and speed (i.e., a given power/speed point), the speedfactor is the distance to the normalized power/speed point from the zero power, zero speed point. The value of the speedfactor is defined as:

$$\text{Speedfactor} = \sqrt{(\text{power})^2 + (\text{speed})^2}$$

(2) Calculate speedfactors for the power/speed data points on the lug curve, and determine the maximum value.

(3) Maximum test speed is the speed at which the maximum value for the speedfactor occurs.

(e) For constant-speed engines, rated speed is the maximum test speed.

§94.108 Test fuels.

(a) *Distillate diesel test fuel.* (1) The diesel fuels for testing marine engines designed to operate on distillate diesel fuel shall be clean and bright, with pour and cloud points adequate for operability. The diesel fuel may contain nonmetallic additives as follows: cetane improver, metal deactivator, antioxidant, dehazer, antirust, pour depressant, dye, dispersant, and biocide.